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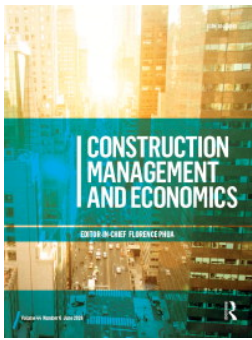
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Digital platforms for circular construction: incumbent supply chain actors' perceptions of emerging intermediaries in the Dutch context

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ABSTRACT

Digital platforms are increasingly promoted as key enablers of circular construction, yet empirical insight remains limited into incumbent supply chain actors' needs and experiences with these platforms as emerging intermediaries. Addressing this gap, this study examines the perceptions of supply chain actors operating within the Dutch construction sector, drawing on 18 semi-structured interviews, a focus group workshop, and observations from two national circular digital transition programs. Building on existing research, digital platforms are conceptualized not merely as technical infrastructures, but as intermediaries embedded within existing supply chain practices and coordination arrangements, forming triadic relationships between supply and demand actors. Accordingly, the analysis is structured according to different intermediation needs across material flows, support flows, and systemic coordination. The findings indicate that digital platforms are widely expected to enhance supply-demand visibility and matchmaking, support compliance with evolving circularity-related KPIs, and facilitate cross-sector coordination. However, their adoption and perceived value vary substantially across actors, product types, and supply chain configurations, with persistent challenges in coordinating material logistics, accounting for environmental and social externalities and managing evolving platform power dynamics. The study contributes to construction management and circular supply chain research by advancing the concept of intermediaries for examining how digital platforms shape circular transitions. It further highlights the importance of more context-sensitive platform design and governance arrangements that respond to diverse intermediation needs and underlying platform dynamics in the transition to circular construction.

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Digital platforms; intermediaries; supply chain; circular economy; construction industry; systemic transitions

Introduction

As societies increasingly grapple with climate change, resource depletion, and escalating waste problems, the circular economy has emerged as a transformative framework for rethinking production and consumption systems (Kirchherr, Reike, and Hekkert 2017; Ellen MacArthur Foundation 2019). Central to the circular paradigm is the reconfiguration of supply chains. Circular supply chains challenge the dominant linear logic of 'take-make-waste' by promoting whole-life cycle thinking, reverse logistics and closed-loop strategies such as reuse, remanufacturing and recycling (De Angelis, Howard, and Miemczyk 2018; Farooque et al. 2019; Ayati et al. 2022). Among the various sectors in the circular transition, construction represents a critical domain due to its high material consumption and waste generation (Chen, Feng, and Garcia de Soto 2022; Yu, van den Berg, and Yazan 2024). In response,

the Netherlands has committed to a fully circular construction economy by 2050 (Ministerie van Infrastructuur en Rijkswaterstaat 2019). Yet, implementing circular supply chains in construction remains challenging due to the sector's highly fragmented supply chain structure (Ambekar et al. 2021; Rasi et al. 2023). Project-based organization and the dominance of small and medium-sized enterprises (SMEs) create structural gaps and information asymmetries across forward and reverse logistics actors, increasing coordination efforts (Burt 2004; Koolwijk et al. 2018; Burt and Soda 2021; Wijewickrama, Rameezdeen, and Chileshe 2021; Ding, Wang, and Chan 2023).

To tackle the structural gaps in circular supply chains, digital platforms are increasingly recognized as crucial new intermediary actors (Benassi and Martin-Sanchez 2022; Li, Maxwell, and Moehler 2025). A digital platform can be understood as an ICT-

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enabled system that creates and governs a shared environment for multiple independent actors to interact, exchange information, and transact (Ciulli, Kolk, and Boe-Lillegraven 2020; Benassi and Martin-Sanchez 2022; Li, Maxwell, and Moehler 2025). In this study, we conceptualize digital platforms as a novel form of intermediary in supply chains, expanding the concept to situate digital platforms as actors not merely facilitating technological functionalities, but also bridging knowledge, trust, and improving network coordination (Soundararajan and Brammer 2018; Ciulli, Kolk, and Boe-Lillegraven 2020; Rosca et al. 2022; Moglia et al. 2023). In practice, such platforms may take different forms, including digital marketplaces for secondary materials, information platforms that manage product and lifecycle data, and collaborative platforms that coordinate multi-stakeholder initiatives. The construction sector has recognized the potential of digital platforms in the circular economy, particularly for closing key information gaps in tracing material flows and matching supply and demand for reuse (Ciulli, Kolk, and Boe-Lillegraven 2020; Orko et al. 2023; Yu et al. 2023; Budde, Laglia, and Friedli 2024).

To explain the role of digital platforms in coordinating circular construction, we draw on the concept of intermediation as applied to supply chain transitions. Intermediation refers to the involvement of third parties (intermediaries) to bridge actors' supply with demand and facilitate collaboration across fragmented networks (Hargadon and Sutton 1997; Kivimaa et al. 2019; Bergek 2020). In the supply chain management field, studies suggest that supply chains should be understood as triadic rather than purely dyadic relationships, with intermediaries often occupying the position of the third actor between suppliers and customers (Kistruck et al. 2013; Rosca et al. 2022; Bals et al. 2024). Both supply chain management and socio-technical transition studies emphasize the role of the intermediaries as the response to persistent structural barriers, such as fragmentation, information asymmetries, and coordination failures (Moss 2009; Cole and Aitken 2020). Originating from the notion of 'middlemen' in trade, the concept of intermediaries has since evolved across fields including innovation systems, sustainability transitions, and urban governance (Howells 2006; Moss 2009; Kanda et al. 2018, 2020; Kivimaa et al. 2019; Cramer 2020; Hyysalo et al. 2022).

The emerging role of digital platforms aligns with the broader body of literature highlighting intermediaries. Pioneering studies have examined how digital platforms can act as intermediaries in sustainability transition, addressing areas such as digital governance

in multi-level supply chain networks (Rosca et al. 2022), the establishment of global green supply chains (Cole and Aitken 2020), the role of ICT-based innovation brokers (Kochańska et al. 2023), and the facilitation of circular material flows (Ciulli, Kolk, and Boe-Lillegraven 2020; Budde, Laglia, and Friedli 2024). However, existing research primarily focused on the intermediaries themselves, such as platform owners or platform governance agents, rather than on incumbent supply chain actors who use and interact with the platforms. Although a small number of recent studies examined stakeholder requirements for digital platforms (Dharmapalan, O'Brien, and Morrice 2025; Mujahed et al. 2025; Ruismäki et al. 2025), first-hand practical insights from the perspectives of supply chain actors remain limited, particularly in the construction sector, where digital platform-based intermediation is still emerging.

Therefore, this study examines incumbent supply chain actors' perceptions of digital platforms as emerging intermediaries in circular construction, encompassing their intermediation needs and platform-related experiences. Empirically, the study draws on two interrelated innovation programs in the Dutch construction sector, comprising a network of product suppliers, contractors, developers, public bodies and other stakeholders navigating through the circular transition programs, which consist of the development of a digital information exchange platform. In this setting, vivid examples of digital platform-driven intermediation in the supply chain network are being observed (Ministerie van Infrastructuur en Rijkswaterstaat 2019; Yu et al. 2023; Tsui et al. 2024; Van Uden et al. 2025). Adopting a three-fold framework of intermediaries' roles that distinguishes material flows, support flows, and systemic transition processes, the study analyses how intermediation needs are articulated in practice, how supply chain actors engage and operationalize digital platforms as new intermediaries, and how misalignments emerge between platform-based intermediation and the evolving realities of circular construction supply chains. The following sections first outline the theoretical framework of intermediation in circular supply chains and the emergence of circular digital platforms, before presenting detailed empirical findings and discussing implications for advancing circular construction with digital platform-based intermediaries.

Theoretical framework

To unpack the complexity of digital platform-based intermediation in circular construction supply chains,

we take a two-step theoretical approach. First, we review the theoretical debate on intermediation for the circular transition in supply chains. Based on the literature, we categorize three intermediation types in circular supply chains. Second, we introduce how digital platforms are emerging as a new intermediary to link supply and demand sides in the construction supply chain for the circular transition.

Intermediation for the circular transition in supply chains

While intermediation is a widely recognized concept and phenomenon, literature states that there lacks consensus in the definition of intermediaries across different strains of literature, such as supply chain management, innovation systems and transition studies (Kant and Kanda 2019; Kivimaa et al. 2019). An interesting etymological origin of the concept dates back to the ‘middlemen’ in agriculture, wool and textile trade in the early industrialized society of the UK, who were traders of goods that also carried crucial knowledge and information across the industries to facilitate new practices (Howells 2006: 716). The historical concept suggests the dual function of intermediaries in production and innovation systems, which also corresponds to the definition of innovation intermediaries by Howells (2006: 720) as ‘an agent or broker in any aspect of the innovation process between two or more parties’. It also indicates that the phenomenon already co-existed with primitive forms of supply chains, where more complex production and distribution networks evolved from simple forms of commodity trade; and new types of market players or so-called ‘third parties’ emerged, due to more sophisticated technologies and knowledge involved in the transactions.

From the perspective of transaction cost economics, intermediaries are viewed more as connectors or bridges facilitating interactions between buyers and sellers in a market. There, a distinction is made between the financial terms of ‘dealers’, who keep and handle inventory, and ‘brokers’, who offer services without owning inventory (Scholtens and van Wensveen 2003; Chan 2019; Li and Li 2020; Rosca et al. 2022). In supply chain management literature, this perspective is reflected in the observation that the delivery of products or services from suppliers to final customers often involves multiple intermediary stages, such as wholesalers, certifiers, or logistics service providers (Ding, Wang, and Chan 2023; Gupta et al. 2024). The theory of supply chain intermediation

examines a ‘triadic’ dynamic instead of ‘dyadic’ models to understand network relationships and transaction cost, in which a third-party actor becomes a key unit of analysis that shapes exchanges between buyers and sellers by restructuring information, risk, and coordination (Kistruck et al. 2013; Rosca et al. 2022). This theory is applied to analyse how intermediaries shape interactions between supply- and demand-side actors to reduce disparities or inefficiencies and devise innovative strategies to improve the business activities (Spulber 2003; Kistruck et al. 2013). For example, intermediaries such as wholesalers, hub firms or logistics distributors, who connect a large number of upstream and downstream entities, usually play ‘central’ network roles to reduce the transaction cost of establishing individual relationships between different supply chain tiers (Kumar et al. 2022; Gupta et al. 2024).

Supply chain intermediation theories have also recently been developed to address specific, long-term transitional goals of carbon neutrality, climate resilience, and social equity (Chennak, Giannakas, and Awada 2023). However, current research revealed a lack of theoretical grounding and empirical insight into how intermediaries help the moderation of complex, interdisciplinary, multi-level supply chain networks to navigate the systemic challenges posed by the circular transition (Ripanti and Tjahjono 2019; Rasi et al. 2023). Because circular economy calls for a fundamental reconfiguration of supply chain systems, often without standardized pathways, there is a clear need for new forms of intermediaries to bridge structural gaps. These intermediaries are crucial for enabling new connections and facilitating key inter-organizational processes that would be otherwise difficult in traditional supply chain practices (Stella, Claudia, and Alessandro 2022; Moglia et al. 2023). Thus, the concept of transition intermediaries in the study of socio-technical systems offers a valuable lens for studying circular supply chains, integrating traditional ‘middlemen’ roles focused on efficient material flows with those new roles of transition agents and brokers who enable innovation niches, cross-sector coordination, and long-term system change (Nielsen, Majumder, and Saha 2019; Rosca et al. 2022; Moglia et al. 2023). Socio-technical transition studies conceptualize intermediaries as actors or organizations that operate between providers, regulators, and users to translate knowledge, coordinate activities, and reshape relationships within socio-technical systems. Their roles are defined by both ‘in-betweenness’ in network structures and ‘embeddedness’ in market and institutional contexts (Moss 2009; Hyysalo et al. 2022).

To develop an analytical framework that would help understand supply chain intermediation for the circular transition, we take the perspective to distinguish the focus of material flows and support flows (Carter, Rogers, and Choi 2015; Rosca et al. 2022). Material-flow intermediation focuses on roles that manage inventories and physical goods within supply chains, often described as ‘dealers’. In contrast, support-flow intermediation refers to ‘broker’ roles that facilitate service, information, and financial flows, which co-exist alongside material flows in supply chains. Rosca et al. (2022) and Adobor (2019) conceptualize supply chain intermediation as a multi-level process, emphasizing triadic relationships among multiple intermediaries across supply and demand sides within supply chain systems. For the construction context, Ding, Wang, and Chan (2023) proposed a product lifecycle and logistics-based framework that distinguishes inventories, information channels and network coordination that need intermediation in construction supply chains. In these views, intermediaries not only facilitate transactional processes and closed-loop material flows in circular supply chains but also take

roles as service-based or systemic actors that support and coordinate the transition process to circularity.

Building on the theories of supply chain intermediation, incorporating the view of triadic material and support flows as used by Rosca et al. (2022) and the circular construction supply chain framework by Ding, Wang, and Chan (2023), we illustrate the three types of intermediation occurring in circular construction supply chains (Table 1). (1) *material-flow-focused intermediation*, which supports the movement and coordination of products and materials; (2) *support-flow-focused intermediation*, which facilitates supply chain processes such as information exchange, certification, and coordination; and (3) *systemic intermediation*, which extends beyond project- or process-specific flows to connect supply chain actors with broader stakeholder groups and institutional levels.

Platforms as intermediaries in circular supply chains

A growing body of literature identifies information gaps in complex, multi-stakeholder networks as a key

Table 1. Types of supply chain intermediation (based on literature).

Intermediation types	Emergence	Diagrams of intermediation types in circular supply chain networks (triadic relationship)	References
<p>Type 1 Material-flow-focused intermediation</p> <p>Focused on dealing with materials or products, often involves physical space or handling of physical products</p>	<p>Evolved from traditional supply chain roles, or established as addition to the supply chain infrastructure</p>		<p>(Popp 2000; Howells 2006; Ciulli, Kolk, and Boe-Lillegraven 2020; Wijewickrama, Rameezdeen, and Chileshe 2021; Rosca et al. 2022; Stella, Claudia, and Alessandro 2022; Ding, Wang, and Chan 2023)</p>
<p>Type 2 Support-flow-focused intermediation</p> <p>Perform broker roles for information and financial flows, or intermediate between the supply chain and local projects to facilitate circularity</p>	<p>Emerge within supply networks or newly established functions performed by supply chain partners</p>		<p>(Popp 2000; Howells 2006; Kivimaa et al. 2019; Cole and Aitken 2020; Hyysalo et al. 2022; Rosca et al. 2022; Ding, Wang, and Chan 2023)</p>
<p>Type 3 Systemic intermediation</p> <p>Connecting also mainly supports flows but not directly associated with material supply chain processes. Typically established to coordinate whole systems and connect beyond projects or branch boundaries</p>	<p>Often established by the regime or functioned through institutions for the purpose of supporting systemic transition</p>		<p>(Howells 2006; Kanda et al. 2018, 2020; Kivimaa et al. 2019; Cramer 2020; Rosca et al. 2022)</p>

barrier to circular supply chains (Wijewickrama, Rameezdeen, and Chileshe 2021; Kočańska et al. 2023). These gaps, ranging from missing material data, unclear product responsibilities and lack of coordination between actors, hinder the scaling of circular systems (Çetin, Gruis, and Straub 2022; Kočańska et al. 2023). In response, digital platforms have increasingly been recognized as a promising enabler of circularity, offering new tools to capture, manage, and exchange information across systematic boundaries. Evidence across industries shows that intermediation in the circular transition increasingly hinges on digital platforms, which act as ‘e-intermediaries’ capable of addressing persistent coordination and information challenges (Boyle, Humphreys, and McIvor 2008; Cui, Li, and Kamoche 2021; Moglia et al. 2023).

In practice, the three types of supply chain intermediation, focused on material flows, support flows and systemic interventions, are all increasingly equipped with a digital layer. Platforms such as ‘Too Good To Go’ in the food retail industry and the Dutch circular construction products marketplace ‘INSERT’ are examples of product-focused transaction platforms in the form of a digital marketplace. They do not own inventories but facilitate flows of secondary resources to prevent waste (Ciulli, Kolk, and Boe-Lillegraven 2020; Rosca et al. 2022). In the European building materials sector, platforms such as Madaster and Circq are being piloted as support flow-based information platforms, which pilot integration of digital product passports (DPPs). These systems accompany material flows and provide lifecycle data to guide circular economy decisions (Bragança 2019; Heisel and Rau-Oberhuber 2020; Çetin, Gruis, and Straub 2022). Additionally, multi-stakeholder innovation platforms showcasing pilots, aligning policies and facilitating cross-industry matchmaking are assisting traditional systemic and institutional intermediaries with more efficient, cost-effective digital interfaces (Rosca et al. 2022; Kočańska et al. 2023; Moglia et al. 2023).

In the context of the European construction sector, researchers also emphasize the need for more integrated and interoperable ICT infrastructure to support circular practices. Technologies such as material life cycle tracking, digital product passports (DPPs), digital twins, geo-information platforms, ontologies and building information modelling (BIM) are among the key enablers being explored to enhance transparency and coordination in circular supply chains (Ciulli, Kolk, and Boe-Lillegraven 2020; Çetin, Gruis, and Straub 2022). These technical applications exemplify how digital platforms are assuming an increased

intermediary role to mitigate coordination barriers and align supply with demand: not only for material transactional processes, but also for the critical flow of knowledge and information across stakeholders (Orko et al. 2023; Yu et al. 2023; Budde, Laglia, and Friedli 2024; Van Uden et al. 2025).

To theorize how digital platforms emerge as new intermediaries within supply chain networks, this study adopts the perspective of incumbent actors, an analytical lens shared in prior research on digital platforms adoption (Hein et al. 2019; Dharmapalan, O’Brien, and Morrice 2025; Mujahed et al. 2025; Ruismäki et al. 2025). Actor-centered approaches have been used to examine how platforms are interpreted, positioned, and evaluated within existing organizational and supply chain arrangements, including how coordination roles, data requirements, and circular economy ambitions are articulated (Budde, Laglia, and Friedli 2024; Orko et al. 2023).

Building on this literature, this study conceptualizes digital platforms not as purely technical artefacts but as intermediation mechanisms that occupy an in-between position within supply chain networks. This conceptualization foregrounds how supply- and demand-side actors make sense of emerging platforms, articulate intermediation needs, and anticipate or reflect on platform adoption and use as part of broader processes of the transition to circular supply chains.

Methodology and context formulation

The Dutch construction supply chain context

In this study, we are embedded as engaged scholars in two interrelated Dutch government-funded circular transition programs in the construction industry. The first programme (June 2022–December 2023) was a feasibility study primarily involving material and product suppliers for metal-based construction products and relevant support roles such as designers and product system providers. The second programme (since January 2024) is a continuation of the first feasibility study and focuses on large-scale supply chain digitalization initiatives and brings together a broader group of stakeholders, including clients, design firms, public authorities, and software developers. The purpose of both programs is to co-develop digital platform systems intended to support coordination among supply chain actors in the circular transition of the construction sector. Within this setting, we examine construction products as the basic functional unit of circular material supply chains. Following NEN

15804, a construction product is defined as: 'item manufactured or processed for incorporation in construction works' (NEN 2019).

The Netherlands provides a particularly relevant empirical context for examining how supply chain actors engage with digital platforms as intermediaries to address coordination challenges in fragmented circular supply chains. Construction and demolition waste is already recycled at rates close to 100% (Deloitte 2014), meaning that current policy efforts focus on more ambitious, higher-value circular strategies such as reuse and remanufacturing of building elements in closed-loop supply chains (Çetin, Gruis, and Straub 2022; Ministerie van Infrastructuur en Rijkswaterstaat 2019). However, those higher-value circular channels introduce additional coordination challenges, including high recovery and handling costs, reverse logistics complexities, temporal and spatial mismatches between demolition and market demand, as well as uncertainties regarding the quality, quantity, and availability of recovered materials (Ambekar et al. 2021; Tennakoon, Rameezdeen, and Chileshe 2021). Addressing these challenges requires more intensive coordination across fragmented supply chain actors.

In response, the Dutch construction industry has increasingly invested in digitalization initiatives aimed at improving material transparency, coordination, and matchmaking across closed-loop supply chains (Çetin, Gruis, and Straub 2022; TKI 2023; Yu et al. 2023). Several public-private innovation programs have been launched to experiment with digital platforms and data infrastructures supporting circular construction practices (Ministerie van Infrastructuur en Rijkswaterstaat 2019; Cramer 2020; TKI 2023). These initiatives make the Netherlands a representative context for how digital ecosystems are emerging to assist the circular construction economy.

Research approach

This study adopts an exploratory qualitative research design aimed at theory building (Creswell et al. 2007; Yin 2017). Qualitative methods are appropriate because they allow us to capture situated interpretations, organizational practices, and inter-organizational interactions on emerging platforms. This study addresses an emerging scholarly focus at the intersection of circular transitions and supply chain intermediation, where theoretical foundations remain fragmented and are still actively being developed. Therefore, we apply an abductive analytical approach to develop concepts mainly from empirical data while informed by existing

theories on intermediation (Creswell et al. 2007; Earl Rinehart 2021). The aim is to capture the latest insights from the dynamic supply chain system with respect to the emerging digital intermediation mechanisms.

A purposive sampling strategy was employed to select supply chain actors that are theoretically informative rather than statistically representative (Campbell et al. 2020). The objective was to capture a diverse range of firms and organizations that form the pattern of a circular construction supply chain system. Potential participants of the interviews were identified through three ways: (1) participation in two national digital transition programs related to circular construction, (2) professional networks and industry associations active in circular construction projects, and (3) snowball sampling, whereby interviewees recommended additional relevant actors.

The interview participants were selected from specific organizations based on the following criteria to align sample with the purpose of this study: (1) active involvement in circular closed-loop construction practices such as reuse; (2) direct engagement with digital platforms, digital tools, or data infrastructures relevant to circularity; and (3) representation of different positions within the supply chain, including supply-side actors (e.g. urban miners, remanufacturers, contractors), demand-side actors (e.g. developers, housing organizations, designers), and support actors (e.g. circular material hubs, technical consultants, digital platform developers).

In addition to the interviews, a focus group workshop was organized to validate emerging insights from the interviews and to gather additional perspectives on the role of digital platforms in circular construction supply chains. The workshop included researchers and representatives from governance and public-sector organizations, some of the interviewed participants also attended the workshop. In parallel, the research team conducted participant observation throughout the two transition programs, recording field notes during meetings and project activities to capture additional insights.

The multi-method approach enabled triangulation across data sources and perspectives, strengthening the interview findings through validation. The data collection process is further explained in Table 2. The final dataset includes 18 semi-structured interviews from members of 15 firms, notes from the focus-group workshop, and field notes from observations and multi-stakeholder meetings conducted in the projects.

All interviews and the focus group were conducted using a semi-structured format. The interview protocol

Table 2. Overview of empirical data collection.

ID	Business type	Roles interviewed	Duration
Expert interviews			
The purpose is to gain in-depth insights from a variety of practitioners who either focus on material flows (B, C, E, G, H, I, K, N) or support flows (A, D, F, J, L, O).			
A	Architecture design office	Circular consultant	0 h 58 m
B	Building contractor focused on remanufacturing	Circular specialist	1 h 02 m
C	Building contractor focused on circular housing	Project manager	0 h 46 m
D	Consultant company for sustainable buildings	Project manager	1 h 02 m
E	Circular and bio-based building solution provider	Founder	0 h 58 m
F	Housing organization focused on circular strategies	CEO	1 h 03 m
G	Design-build company for circular projects	Project manager	0 h 53 m
H	Urban miner (demolition contractor)	Director	1 h 10 m
I	Urban miner & reuse-focused contractor	BIM specialist	1 h 28 m
J	Architecture design office	Director	1 h 30 m
K	Contractor focused on circular industrialized building	Director	0 h 59 m
L	Engineering company	Architect	0 h 59 m
M	Digital inventory tracking APP & service provider	Project director	1 h 05 m
N	Remanufacturer of construction products	Circular consultant	0 h 57 m
O	Collaborative digital marketplace platform for circular reuse	Founder	0 h 59 m
		CEO	0 h 48 m
		Director	0 h 29 m
		Director	1 h 45 m
Workshop (focus-group)			
The purpose is to validate the findings and gain insights from the supply chain context, combining different flow types. Participants include industrial practitioners (focused on material and support flows), academic researchers and government workers (systemic actors).			
W	A focus group workshop with around 30 people, divided into 4 groups to discuss and map different product supply chain contexts		03h00m (approx.)
Participant observation (in national programs for digital platform development)			
The purpose is to gain insights and validation from more stakeholders. The participants of the two national transition programs include consortia members of product suppliers, consultants and ICT companies.			
X	A digital transition program focused on the metal façade supply chain in the Netherlands		Jan 2022 ~ Jul 2023
Y	A collective initiative across different sectors to develop a digital integration platform for the circular transition of construction supply chains		Jul 2023 ~ Aug 2025

was designed to elicit participants' experiences with circular supply chain practices and their engagement with digital platforms, with open-ended questions covering material recovery and reuse practices, coordination challenges across supply chain actors, information and data needs, and user experiences of digital platform-based intermediation. The approach allowed core themes to be addressed consistently across firms while providing flexibility to probe emerging issues and practice-specific insights during the conversations.

Empirical data analysis followed an abductive approach, in which the intermediation framework introduced in the theoretical section was used as a sensitizing framework to interpret intermediation needs across material, support, and systemic dimensions of circular supply chains. Interview transcripts, observation notes, and workshop materials were coded iteratively to identify patterns in how supply- and demand-side actors interpret, engage with, and respond to digital platforms as intermediaries. Coding

proceeded through multiple rounds, moving from open coding to more focused thematic categories, allowing emerging empirical insights to be continuously compared with the theoretical framework. Additionally, during analysis, empirical material from different supply chain practices and product configurations was iteratively compared to surface patterned differences in intermediation needs from different supply chain actors and how the digital platforms are involved and experienced. Throughout the analysis, preliminary interpretations were discussed within the research team and iteratively refined to enhance reflexivity and reduce individual researcher bias. Illustrative interview quotations, field notes and the aggregated dimensions derived from the coding process are provided in [Tables 3–5](#).

Results

As outlined in the Theories section, we identify three intermediation types that facilitate the circular

transition within supply chain ecosystems (Table 1). Three data structures of empirical findings are formulated based on the intermediation types (Tables 3–5), through which intermediation needs in fragmented supply chain networks are identified. Subsections of the findings are structured around those intermediation needs identified (second-order construct). The structure reflects how supply chain actors articulate different coordination challenges in circular construction supply chains. Accordingly, the analysis examines how those actors engage with emerging digital platform interventions and where gaps remain between platform-based intermediation and supply chain coordination requirements.

Intermediation for material flows

Within material flow intermediation, actors highlighted several interrelated needs concerning the coordination of reusable and remanufactured construction products across fragmented supply chains. These needs remain distinct due to the diversity of construction products involved and the intrinsic difference between reuse and remanufacturing processes. For each need, actors elaborated on how digital platforms are applied or expected to support the management of material flows in circular construction supply chains.

Scanning and inventory management

At the origin of circular products, primarily the existing built environment, supply-side actors primarily seek intermediation to bridge heterogeneous and fragmented material flows, particularly in high-value reuse and re-assembly strategies for customized products in engineer-to-order (ETO) supply chains. Urban miners and reverse logistics hubs currently play a key physical intermediary role in reuse: aggregating, scanning and storing products, absorbing logistical risks and keeping inventory for future demand. The information gap exists between the asset management of the existing built environment and the inventory management of reclaimed secondary products.

To support these activities, actors increasingly deploy digital scanning tools and inventory systems prior to deconstruction. Several firms reported developing proprietary applications that combine 3D scanning with decision trees to classify recovered elements as reusable products, semi-finished components, or raw materials. This practice facilitates both upstream planning (e.g. closed-loop strategies) and downstream processes (e.g. material matchmaking). However, despite the growing availability of detailed digital

inventories, actors consistently report difficulties in activating demand for recovered materials. Even where inventory data is available, reuse transactions remain highly contingent on timing, relationships, and informal coordination, indicating that digital platforms currently support information creation rather than effective market intermediation.

Searching, matching, and demand prediction under uncertainty

On the demand side for customized reuse products, clients such as housing organizations or first-tier contractors face barriers in sourcing reclaimed or remanufactured products due to fragmented supply channels, limited transparency, and low trust in supply qualities. The variability in product flows brings difficulties, particularly during early-stage design and procurement, when visibility into material availability and lead time is critical but often lacking for circular products. As a result, developers, contractors and architects expressed strong intentions to integrate circular products into design and project planning. There is a growing need for intermediary tools that enable reliable searchability, provide structured and verifiable product data, and facilitate early decision-making in product selection.

To address this disconnection, many firms are exploring digital marketplace solutions, or also named as transaction platforms, to share product data and increase visibility for sales. Currently, these platforms often enable demolition professionals to upload inventories of reclaimed materials in advance, theoretically creating more lead time for potential reuse. Nonetheless, interviews reveal that in the current Dutch market, open digital marketplaces for construction product reuse remain in limited practice. Most of the platforms are mainly serving internal needs or pre-existing networks of trusted buyers. Even when inventory data is made available, executing actual transactions remains a complex and resource-intensive process, hindered by logistical constraints and persistent issues around data reliability and trust between actors. As a result, existing digital marketplace platforms tend to increase informational visibility without fully mediating the commercial, contractual, and risk-related dimensions required to activate demand at scale.

Streamlining reverse and forward logistics

Furthermore, in projects that conduct reuse and re-assembly of second-hand products such as windows and doors, the coordination challenge is highlighted

Table 3. Empirical data structure for material flow intermediation needs.

ID.	Example of interview/report quotations	First-order construct	Second-order construct
I	"We created the inventory app ourselves with an inventory scan function and an inventory decision tree... And then we first extract it as a product, then decide to reuse as a semi-finished product or as a raw material."	Digital scanning & reuse inventory creation	Scanning information of circular products and inventory
M	"... We use our own software to make inventories of buildings... We know this building is going to be demolished in two months' time. We know what it contains and how it's fixed. We would really like demolition contractors to use this as well, so we can have information about their supply"	Scanning app for data sharing about reusable products	
I	"The demolition contractors already know most of these buyers. So basically, when they want just to get rid of it, we will take care of all the logistics... the communication. I'm trying to streamline it with my business partner, software engineer... so we try to make that more efficient."	Coordination between demolition supply and project demand	Searching and demand prediction for customized and standardized circular products
M	"Where we make money is by trying to get certain materials from one demolition project directly to another project... that's where we can make the margin."	Business based on reuse channels	
M	"Because the new price is about €10,000, I was able to ask 5000 for it... By just making a few phone calls, right? It's just I went there. I thought like, oh, this might be a match. I called the moving company... They did their job and I got paid. That's the added value, the information part."	Gaining value through information channels for reuse	
M	"That (platform) has developed the marketplace and we can now also use it as an intra-marketplaats, so for clients who want to keep their own products for reuse."	Different levels of openness for digital marketplace platforms	
N	"... if they have a new project, they can pull it directly to the site... otherwise the cost will increase... if it's outside, they have a problem with the rain... if you have to store it inside... it costs you money... There is no certainty that anyone will be interested to buy them in the future."	Time and inventory risk issues are involved in circular products	Need for streamlining logistics and inventory management
N	"I think the standardization of the products we sell is a kind of prerequisite to be able to make this a success and to scale it up... The current size we have is not profitable because we do not have the volumes yet... But the prerequisite is that it is a standardized product at the end."	Necessity for product standardization in remanufacturing practice	
C	"The biggest problem is time. If you promise something, then you need to deliver. But you can promise... only if you ask all the parties what material is available... they cannot hold it forever"	Issues of time mismatch between supply and demand for reuse	
H	"Demolition contractors have only... 3 weeks or 4 weeks... there is hardly a business case for taking it apart carefully."	Time limit for data collection for circular reusable materials	
B	"JIT delivery is the most difficult to achieve, since material needs in construction are often finalized late, misaligning with demolition schedules for sourcing reclaimed materials."	Difficulty for JIT delivery	
B	"It was all company data... they were not allowed to share it and to say which company had which waste stream. And so that was also an issue we encountered there."	Trust and confidentiality barriers in material flow data	Segmentation for data needs and data ownership
N	"There are several reasons, but the first one is that I want to want to maintain the supply channel. I do not want to skip the wholesaler because they currently do supply the brands that are new, and they make money on it of course. And I do want to make money on my products as well, otherwise they will see me as a kind of threat or competitor."	Fear of competition with traditional supply channels	

Table 4. Empirical data structure for support flow intermediation needs.

ID.	Example of interview/report quotations	First-order construct	Second-order construct
A	"I think you need a very broad knowledge for circular construction. Sometimes I feel more like a director than an architect ... The role of an architect in circular construction is much broader than just making a beautiful building ... So, we can make our role more important in the process of a circular building."	Role change and increased need for circular design consultancy	Increased need for knowledge sharing and consultancy
G	"We use BIM platforms, and we build our own template inside the software, where we mark which materials are from a circular source, or are going to be reused, or need to be dismantled carefully."	BIM-based design and simulation for reuse integration	
I	"We do not have any certification on products that we demolish. Then the question immediately arises: who provides the guarantee?"	Lack of guarantee and certification for reused products	Need for standardization of fragmented data sources between actors
C	"... If this platform is fully functional, it will connect all the information so beforehand about what material are coming ... but it's complicated. There is a lot of missing or inaccessible information."	Difficulty to acquire information for material reuse	
K	"We want to use digital twins to help make better decisions rather than just make the buildings ... all the data it needs, can be models or schedules, someone needs to provide that data."	Digital twins limited by data availability	
H	"... there are many technologies that are not clearly defined, and especially with the challenge with the problem of a building product is that the manufacturers and construction sectors are not using the same standards."	Lack of standardized information exchange formats between sectors	
D	"... do you see there is this risk in different KPI and calculation methods ...? If you take a different method the results can be quite off ... Ask three people to do an LCA and you get three different answers ... give a BIM model to four different parties, they all create a different LCA ... there's so much information ... you don't have that full clear picture."	Misalignment in KPI calculation methods	Sourcing and procurement needs based on circular KPIs
L	"More often we get the question 'make it circular' and nobody knows what circularity is. My first question is what do you mean with circularity? We have the discussion about the goals. sometimes the goal of 35% bio-based insulation material. Also the question is how do you make it measurable? "	Need for measurable KPIS for circular projects	
B	"The most important thing for us is that the clients themselves have an objective in the field of circularity, so a hard KPI is actually a key performance indicator. If they really have the ambition as a client, we do something with circularity ... "	KPI alignment between supply and demand	

due to the labor-intensive processes and alignment with downstream construction timelines. Firms in this segment reflected that just-in-time (JIT) delivery is especially difficult due to the project-based model that demands constant alignment between demolition schedules with late-stage design decisions, permitting delays or environmental disruptions. Therefore, the contractors and manufacturers show strong interest in digital intermediation to support spatial-temporal optimization of workflows, production planning, and coordination with contractors and production workshops.

In contrast, for standard-sized products such as circular ceiling tiles and wall panels, make-to-stock (MTS) remanufacturing models benefit less from detailed inventory tracking and coordination. Because the products are standardized, firms in this configuration typically source consistent-quality inputs from a small set of suppliers and operate from centralized production facilities. Their operations are less affected by project-specific conditions and more focused on throughput efficiency. Consequently, intermediation

needs in MTS models are less about coordinating internal production schedules and more about optimizing reverse logistics. Actors express the need to further enhance efficiency by integrating return flows with forward distribution routes, improving transport planning, stock monitoring, and communication.

Segmentation of data needs and platform access

Furthermore, attitudes towards open digital platforms also vary due to the different market positioning of the actors. Reused-material sellers and clients embrace open platforms more positively, viewing them as tools to increase visibility and mitigate inventory risks. In contrast, standardized-product remanufacturers (MTS) are more reluctant. Most remanufacturers have long-standing relationships with wholesalers or big customers, which guarantee stable product prices and minimum order quantities.

In remanufacturing supply chains, the engagement with digital platforms takes a more inward-facing form. Accurate and interoperable product data are shared through BIM models and ERP systems within

Table 5. Empirical data structure for systemic intermediation needs.

ID.	Example of interview/report quotations	First-order construct	Second-order construct
I	"You cannot do this as a company alone, you have to do it together. We are moving further and further forward. You also begin to work as raw materials or as a product supplier and even as an advisor."	Collaboration and new market creation	Scaling-up circular business models across sectors
M	"The business of urban mining in general is really risky economically: high storage costs, high uncertainty on the value of the materials, time pressure ... we're now setting up this ecosystem for collaboration."	Ecosystem development for risk sharing	
B	"... this coating is applied by a very expensive machine, really big and expensive coating machine that costs a couple of €1,000,000, so only the big glass manufacturers have fits and all of the small glass manufacturers don't. And the big suppliers are not really interested yet in remanufacturing ..."	Need for new integration in supply chains	
Y	During a multi-stakeholder meeting (09-01-2024), concerns were raised about the practical feasibility of platform adoption among the approximately 30,000 subcontractors active in the Dutch construction sector, particularly with regard to time constraints and digital skills required for engagement.	Lack of capacity by SMEs	
D	"People are wondering, is it worth it to implement material passports. There's quite some work to do that for an existing building and involves quite some cost. These tools could actually have multiple uses, to close a lot of information gaps to report, to inform, to make informed decisions."	Need for networked business models across firms	
E	"I wish there would be some digital tools where you can get more and more innovative solutions. I have a feeling it's a more traditional industry, right now suppliers basically provide information on old channels."	Need for innovation platforms to share innovative solutions	Spreading innovation through open platforms
G	"We are working with manufacturers, trying to make digital information platforms, particularly for circular economy, but that's the manufacturing side, then later we can integrate those from construction."	System integration of digital platforms between sectors	
X	Program documentation (14-02-2024) emphasizes the deliberate avoidance of 'vendor lock-in' by requiring multiple IT providers to jointly develop standardized interfaces for each platform functionality, with the explicit intention of proposing these interfaces as national or international standards.	Strategies to avoid data monopolies	
Y	In a multi-stakeholder meeting (11-07-2025), participants articulated the envisioned circular platform as an open, modular infrastructure, in which multiple IT solutions could coexist per functional module and interoperability between subsystems would be enabled through open API standards.	APIs through open standards	

the enterprise and the dedicated supply chains. The use of platforms is primarily focused on product design and development, mainly for improving coordination rather than facilitating transactions. In these cases, actors suggest that open platforms provide limited additional value for their operational needs, while simultaneously posing risks of disrupting established market roles, coordination routines, and existing commercial relationships.

Intermediation for support flows

Within support flow intermediation, actors highlighted several needs related to enabling information sharing, standardization and sourcing of products. These needs arise from the fragmented information and limited transparency across supply chain networks, especially regarding the circular key performance indicators (KPIs). For each need, actors elaborated how digital platforms are expected to support information

channels and facilitate collaboration and the current bottlenecks.

Sharing of circular knowledge and best practices

A first aspect of support-flow intermediation concerns the translation of circular knowledge into actionable design and project decisions. Interviewees describe a significant expansion in professional roles, particularly for architects and consultants, who increasingly act as coordinators and knowledge brokers. This shift reflects a broader scarcity of shared understanding of circular construction practices.

Digital platforms are increasingly envisioned as spaces for inter-organizational knowledge sharing. Several actors highlighted efforts to develop integrated systems that combine technologies such as ontologies, BIM, information delivery specifications (IDS), and DPPs tailored to circular construction supply chains. The initiatives envision a platform that will better align design specifications and jointly respond to

procurement or regulatory demands. However, challenges persist in interoperability, particularly across different product groups and sectors. For example, the reuse of structural timber (ETO) will have totally different data requirements and process constraints compared to remanufactured tiles (MTS). The involved construction firms and manufacturers also use distinctive standards to document products and processes. In addition, actors also reported difficulties in acquiring accurate, real-time project data. The existing built-environment domain contains largely misaligned data between 'as-built' and 'as-maintained' situations, in demolition and early construction phases, time constraints limit the ability to document reclaimed products properly for supply chain actors in the downstream to use.

Standardization and legitimization of circular products

On the supply side, specifically, construction firms and manufacturers are under mounting pressure to comply in specifying, guaranteeing, and legitimizing circular products, in order to meet demand for new circular KPIs. Metrics such as the Dutch Environmental Performance Score (MPG), Building Circularity Index (BCI), life cycle assessments (LCA), and environmental product declarations (EPD) now influence access to permits, procurement qualifications, and public subsidies. Yet, the difficulty for legitimization varies across different product types. Standardized MTS supply chains can more easily integrate certification for circular products, while reuse practices and ETO remanufacturing often struggle to certify their delivered products or provide performance guarantees. This creates a growing demand for intermediaries to translate evolving regulatory expectations to project-specific contexts for circular products.

For contractors and suppliers, platform use is increasingly shaped by sustainability reporting obligations. Many depend on DPP-connected tools that link to national material databases, enabling automated calculation of LCA, CO₂ savings, nitrogen reductions, and other environmental indicators. These digital tools simplify compliance checks and reduce the administrative load typically associated with sustainable documentation. Yet not all actors express confidence in the current digital platforms available. Compliance and reporting still heavily depend on manual, error-prone processes. Ambiguities remain in the KPI calculations, and there lack of clarity on roles and responsibilities for managing lifecycle data of materials and products. Particularly in reuse and ETO remanufacturing, the

transaction cost for acquiring reliable data is much higher than in MTS supply chains; therefore, certifying the heterogeneous materials remains a significant barrier.

Sourcing and procurement of circular products

On the demand side, actors such as housing organizations, developers, and architects report the lack of access to reliable channels for sourcing circular products or assessing their performance through aligned circular closed-loop strategies and KPIs. Actors frequently report that circularity ambitions are vaguely defined at the outset of projects, often framed simply as 'make it circular', without clear agreement on objectives, indicators, or feasibility. Many interviewed professionals acknowledge an information gap that inhibits the incorporation of circular practices into design and procurement processes. As a result, specialized consultants and designers have become central figures in intermediary roles that bridge the information gaps. They offer technical expertise on reuse, disassembly, and material selection, and often shape early-stage planning in ways that unlock downstream possibilities for circular sourcing.

To support the intermediation functions, actors in the Dutch construction sector are increasingly adopting digital platforms to meet growing demands for transparency, coordination, and compliance. Demand side actors show particular interest in centralized material data to facilitate new procurement practices and funding schemes linked to advanced circular KPIs. Therefore, technical consultants and design professionals describe BIM and DPP-integrated platforms as essential during early-stage planning. These tools allow for annotating reusable materials with circularity attributes, simulating disassembly options, and embedding lifecycle criteria into design specifications. At the same time, actors also reported that platform use is limited by fragmented and incomplete data, misaligned KPI calculation methods, and unclear responsibilities for data provision and maintenance across organizations. Consequently, physical actors such as building cost specialists and technical advisors remain necessary to bridge persistent information and governance gaps across the supply chain.

Intermediation for systemic transitions

Within systemic transition intermediation, actors highlighted several needs related to enabling broader coordination and alignment across the industry. These needs stem from the structural barriers between

sectors and governance levels, as well as the lack of shared standards and infrastructure to support circular innovation. Actors also reflected on how digital platforms may contribute to aligning systemic transition goals, and the complexities remain in practice.

Scaling up circular practices and business models

While circular economy policies call for broad reconfigurations across sectors, many firms in the Dutch construction ecosystem, especially SMEs, struggle to navigate fragmented policies, conflicting standards, and sectoral silos. This disconnection highlights a growing demand for intermediation that bridges gaps between institutional frameworks and industry practices. In general, multiple supply chain stakeholders are seeking digital tools that can bridge systemic boundaries. Circular supply chains are increasingly demanding horizontal collaboration models that span beyond single branches of construction product supply chains, which also extend beyond traditional project boundaries. For example, in the remanufacturing supply chain of wooden window and door products, where production of coated glass from reclaimed resources required merging business operations between contractors and glass suppliers. The business model was unfeasible under prior coordination methods. In this case, new platform infrastructure is desired for businesses and stakeholders in the cross-sector setting to share information and co-develop solutions.

Empirical findings show that supply chain actors increasingly view digitalization as essential for bridging systemic governance gaps, especially in coordinating industrial networks. In the Dutch case, industrial associations and government bodies are promoting the development of digital platforms to support standardized information management, including material documentation, environmental performance data, and compliance documentation such as integrated DPPs. Firms in the sector are also exploring different plug-in solutions such as ontologies, AI-driven platforms, and blockchain as components of the platforms. For SMEs, institution-backed platforms offer shared infrastructure to overcome constraints in knowledge, ICT capacity and resource burdens. Nevertheless, digital adoption remains uneven. Barriers persist with limited internal capacity to manage ICT systems. Firms expressed concerns over the lack of immediate business incentives, considering the extra cost and time for onboarding. Concerns over lacking business models and adoption cost are the key gaps addressed by stakeholders against institutionally backed digital platforms.

Spreading circular innovation with open platforms

From the perspective of institutional actors that support circular knowledge and policies, such as standard-setting bodies and knowledge institutions, the growing interest in platforms is not only about improving current operations but also about enabling shared infrastructure for constant innovation. For example, shared repositories for best practices and technical knowledge in circular construction are needed for all levels of practices in the supply chain. Industrial associations, such as the collective of metal façade suppliers in the Netherlands, are the key actors in pursuing a more interoperable data infrastructure that could align circular standards for specific categories of products.

However, during the interviews, actors at both the material flow level (e.g. material suppliers) and support flow level (e.g. ICT service providers) express ambivalence towards digital governance platform initiatives. Some view platform owners as both collaborators and potential competitors, fearing that dominant players could monopolize data infrastructure and reshape power dynamics in the already competitive market. To address these concerns, platform promoters are adopting some countermeasures, such as involving multiple IT providers in co-development and committing to open interfaces with the explicit aim of preventing 'vendor lock-in' by ensuring that functionalities are jointly designed and based on a standardized, interoperable interface.

Discussion

This study advances understanding of how digital platforms, as emerging intermediaries, support circular construction, from the perception of incumbent supply chain actors. Drawing on theories related to intermediation in supply chain transitions, we examine what are the expectations of various actors and what are their experiences with the platform solutions about their needs. [Figure 1](#) synthesizes empirical findings to illustrate three intermediation types: product flow, support flow, and systemic intermediation, showing how incumbent actors, emerging digital platforms, and intermediation functions interact across circular construction supply chain networks and broader transition processes. The findings show that platform value is contingent on the focus on material or support flow and different product supply chain channels, while gaps remain in areas such as product information reliability, interoperability, and data governance.

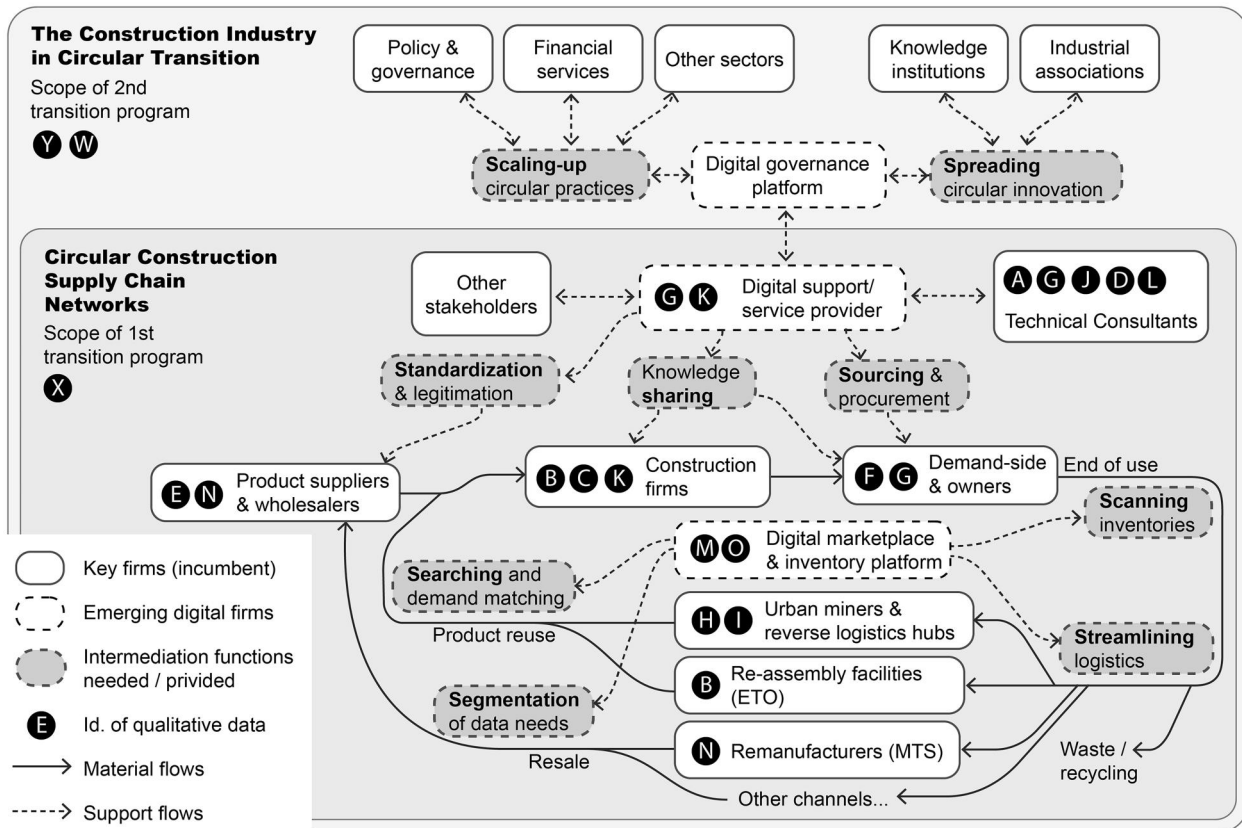


Figure 1. Diagram of three digital intermediation types and the intermediation needs identified based on empirical findings (with incumbent supply chain actors and emerging digital intermediaries illustrated).

While prior research has established comprehensive typologies and definitions of intermediaries and the digital potentials in transition processes (Kivimaa et al. 2019; Kanda et al. 2020), existing work predominantly emphasizes *what* intermediary platforms do, rather than *how* intermediation needs emerge within incumbent supply chain systems and *how* digital intermediaries are interpreted and experienced in response to those needs. Building upon this gap, our research adopts theories of intermediation from supply chain and transitioning socio-technical systems, considering the material flows, support flows, and systemic transitions (Spulber 2003; Grant and Startz 2022; Hyysalo et al. 2022; Rosca et al. 2022). This theoretical lens is built throughout the exploratory study to unpack the intervention of digital platforms both as middlemen in material-focused supply chain operations and brokers of change in broader networks.

Furthermore, this study provides granular, empirically grounded insights into the Dutch construction supply chain, particularly in niche closed-loop circular strategies such as reuse and remanufacturing. This focus on localized, practice-driven dynamics distinguishes our work from prior studies of supply chain intermediaries, which largely examine global supply

chains through a more generic economic lens (Nielsen, Majumder, and Saha 2019; Cole and Aitken 2020; Rosca et al. 2022). The construction supply chain as a key playfield for the circular transition has also been addressed by prior studies due to the sector's vast material consumption (Vihemäki, Toppinen, and Toivonen 2020; Ambekar et al. 2021; Chen, Feng, and Garcia de Soto 2022). The inherently complex and fragmented nature of project-based supply chains amplifies the relevance of considering intermediation and the potential of introducing digital platforms (Bals et al. 2024; Howells 2024). The following discussion synthesizes our findings on material, support, and systemic intermediation and outlines their implications for theory and future development of circular supply chain platforms.

Customized intermediation logics for heterogeneous material flows

At the basic material flow level, by analyzing niche closed-loop circular supply channels that involve different R-strategies, we uncover nuanced relationships between product-driven supply chain configurations

and intermediation needs, as well as different stakeholders' evolving roles and responsibilities when interacting with digital platforms. The results indicate that no universal strategy can effectively provide intermediation for circular construction products. The complexity of a construction product's categories and material types and the circular strategies involved strongly shape intermediation needs in the supply chain. Especially, ETO supply chains of customized products require more granular and timely digital information to coordinate fragmented actors, manage uncertainty, and mitigate inventory and planning risks. This highlights the need for specific, practical goals when configuring digital platforms, especially digital marketplace (transaction platforms), to facilitate information channels for specific transactional needs, subject to different circular closed-loop strategies such as reuse and remanufacturing.

This finding aligns with prior literature on supply chain intermediation through digital platforms, which highlighted that data-driven ICT infrastructure could offer key resources to tackle specific information asymmetry issues between supply and demand, through the sharing of product and transaction data (Boyle, Humphreys, and McIvor 2008; Cui, Li, and Kamoche 2021). The findings also correspond with prior research on transition intermediaries, which suggests that different tailormade intermediation strategies are required to link detailed production processes and respond to user/market requirements in the circular economy (Kivimaa et al. 2019; Hyysalo et al. 2022). Therefore, it may not be realistic to assume that a single digital marketplace platform can effectively connect material flows from deconstruction to new use. Instead, platform solutions need to account for the diversity of construction products and the varying configurations of reverse supply chains, where differences in material quality, recovery processes, and market demand require more tailored forms of intermediation.

From frictions to externality management in circular supply chains

Based on our findings from support flow-focused supply chain actors, it is further emphasized that intermediation is critical beyond the transactional needs in circular supply chains. This has led to the emergence of digital platforms that connect technical consultancy, procurement, and regulatory compliance based on various new KPIs. These findings indicate that circular supply chains require extended forms of

intermediation to bridge support flow gaps related to complex economic, social, and environmental externalities, which in turn create new challenges for effective information management and digitalization in the construction industry. The observation was also reflected by Moglia et al. (2023), that emphasizes the role of digital intermediaries in addressing knowledge barriers and information asymmetry in emerging markets, a contribution particularly relevant for niche circular practices, where viable business models are often limited by high uncertainty and information deficit. Such needs have been highlighted in prior studies, which show that asymmetric information often externalizes environmental and social impacts, leading to market failures in circular supply chains, including practices commonly described as 'greenwashing' (Su et al. 2020; Wu et al. 2023).

The insights align with prior research by Kanda et al. (2018), which highlights the key contribution of intermediaries as linkages addressing externalities, a concept also stressed by Figge, Stevenson Thorpe, and Manzhynski (2022) as a major challenge for the circular economy. This concept introduces a broader socio-economic perspective to explain why intermediation through digital platforms holds significant potential: in the circular economy, the embeddedness of economic activities within environmental and social systems requires substantially greater transparency (Hyysalo et al. 2022). Consequently, the need to measure more complex KPIs, assess broader impacts, and trace performance throughout product life cycles demands significantly greater knowledge sharing and digital integration, often beyond the capabilities of traditional supply chain actors or non-digital intermediaries. In this context, the role of digital platform intermediation extends beyond reducing market frictions between supply and demand, and increasingly involves coordinating information and accountability related to the externalities previously excluded from the domain of construction supply chain management.

Platform governance under new market (and power) dynamics

The findings indicate that digital platforms are increasingly seen as systemic intermediaries, responding to long-term transition goals that extend beyond the needs addressed as part of material and support flows in construction supply chains. In particular, digital platforms established or governed by institutional actors hold potential to facilitate knowledge exchange, enable learning networks and incubate emerging new

circular business models. This resonates with studies by Rosca et al. (2022) and Moglia et al. (2023) that emphasize the multi-level nature of intermediation in sustainability transitions, whereby intermediaries bridge fragmented institutional frameworks, sectoral standards, and organizational practices.

Given the systemic complexity of circular transitions, which span multiple levels of material and support flows across supply chains, the emergence of digital platforms as systemic intermediaries, particularly those led by governmental or institutional actors, can simultaneously enable coordination and introduce new market mechanisms that complicate equitable and effective transitions. There are growing concerns about shifting power and the potential intensified competition due to high entry barriers for SMEs, limited ICT capacity, and fears of platform monopolization. The concern that powerful intermediaries may become monopolies has been previously discussed in literature, particularly in debates over whether intermediaries profit from sharing information or if they primarily benefit by withholding information and charging monopoly rents (Popp 2000; Li and Li 2020; Grant and Startz 2022). Such complexities are observed in our case study, where stakeholders are concerned about shifting market competition and 'vendor lock-in' by platforms. Although digital platforms are still emerging in the construction industry, these findings already point to similar concerns in other sectors where platform intermediation acts on a much larger scale, such as e-commerce giants that have significantly reshaped the retail and manufacturing sectors worldwide (Evans 2016; Hein et al. 2019).

Future outlooks for digital intermediation and platform design

Looking ahead, to provide an outlook on how intermediation will continue to develop, while some scholars positively predict digitalization will eventually balance supply and demand, replacing current physical roles such as reverse logistics hubs and wholesalers through dis-intermediation (Bodin et al. 2021; Yu, van den Berg, and Yazan 2024; Van Uden et al. 2025). Our analysis suggests a more complex trajectory: some incumbent product supply-chain channels, such as those for remanufactured gypsum boards, consider digital platforms as both an opportunity and a threat to existing distribution arrangements, particularly for traditional intermediaries such as wholesalers. Intermediation will likely persist in dynamic forms in the digital era, with incumbent and emerging actors

continuing to add value through material flow coordination, risk management, and liquidity provision, as emphasized in prior studies that underscored the dynamics of supply chain dis-intermediation through a transaction cost economics lens (Hingley, Lindgreen, and Grant 2015; Utar 2017; Nielsen, Majumder, and Saha 2019). Therefore, a key avenue for future research lies in uncovering how digitalization reshapes patterns of dis-intermediation and re-intermediation in circular construction supply chains, and how these evolving dynamics influence coordination, value creation, and governance across established and emerging networks (Nissen 2000; Cole and Aitken 2020; Howells 2024).

For platform design, our study reconceptualizes platform-based digitalization not merely as technological tools, but as active intermediaries that bridge systemic gaps. This perspective aligns with Rosca et al.'s (2022) and Moglia et al. (2023), who argue that isolated technological deployments alone cannot overcome the barriers. Instead, circular supply chains need digital-driven intermediation to connect material flows, support flows (e.g. data sharing, KPI alignment, and externality accounting) and coordinate transitions in multi-level stakeholder networks. This reconceptualization offers a lens for interpreting a range of emerging digital interventions, such as supply chain digital twins (Boje et al. 2023; Ding et al. 2024), blockchain-based supply chain tracking (Amico, Cigolini, and Franceschetto 2022), agent-based AI coordination tools (Ding, Wang, and Zou 2016; Barenji et al. 2019), geo-information platforms and BIM/DPP-based user-interfaces (Kochańska et al. 2023; Budde, Laglia, and Friedli 2024), as forms of intermediation rather than merely technological add-ons.

Conclusions and recommendations

This study investigated incumbent supply chain actors' perceptions of emerging digital platforms as intermediaries in the Dutch construction sector, as reflected in their intermediation needs and experiences. Addressing a gap in existing research, which primarily focuses on platforms themselves, the study adopted the incumbent actor's perspective and conceptualized digital platforms not merely as technical infrastructures, but as 'triadic' intermediation mechanisms embedded in existing supply chain practices, power relations, and institutional arrangements. By analysing based on intermediation needs across material flows, support flows, and systemic coordination, this study clarifies how incumbent actors articulate needs from

digital platforms and how the experienced value of these platforms varies across actors, product types, and supply chain configurations.

Drawing on our empirical findings from the Dutch construction sector, we show that digital platforms already contribute by enhancing product supply-demand visibility, supporting compliance with evolving KPIs, and fostering cross-sector/multi-level collaboration. However, the extent to which these platforms address actors' practical needs is contingent on different supply chain contexts. Platform value varies strongly across ETO and MTS supply chains. Existing platforms support information gathering and KPI tracking rather than resolving transactional, logistical, and business risk-related challenges. Other persistent gaps remain, including high data burdens for heterogeneous products, limited commercial viability for digital marketplaces, difficulties in integrating complex externalities, and growing concerns about shifting roles and market concentration in platform-mediated supply chains.

The study contributes to theory by advancing intermediation as an actor-centred analytical lens for examining how digital platforms shape circular transitions through three types of intermediation: material-flow, support-flow, and systemic intermediation. Rather than focusing solely on the functions of digital intermediaries, the study highlights how intermediation needs emerge from the perspectives of incumbent supply chain actors navigating circular transition processes.

Based on these findings, two key implications can be drawn for circular transition practice and digital platform policy.

First, the digitalization process should not focus solely on the deployment of technologies, but instead recognize digital platforms as intermediaries embedded within the supply chain networks and transition processes. In such, policymakers should recognize that supply chain branches differ in intermediation needs. Platform governance can therefore prioritize specific missing links and bottlenecks in material and support flows, as well as the key collaboration barriers across supply chain levels and sectors. This view may support more targeted platform development and avoid overly generalized platform designs that do not correspond to specific supply chain intermediation needs.

Second, the findings highlight that information asymmetry related to environmental and social externalities and evolving market power dynamics represent key challenges in the circular transition. Thus, effective digital platform policy should not assume intermediaries to be neutral actors operating in

frictionless markets; rather, platforms should be recognized as power-laden actors embedded in supply chain systems.

The limitation of this study lies in its exploratory, theory-building focus and its concentration on a single geographic and sectoral context in the Dutch construction industry. While this design provides in-depth insights into the perceptions on merging digital intermediaries, it does not examine how platform-enabled supply chain systems perform or evolve. Future research could combine qualitative, quantitative or model-based analysis of the performance and development of platform-mediated circular supply chains (Ciulli, Kolk, and Boe-Lillegraven 2020; Rosca et al. 2022; Ding et al. 2024). Moreover, as intermediation is shaped by specific economic and governance models (Kanda et al. 2020; Abbott et al. 2021; Kumar et al. 2022), further studies across diverse regulatory contexts are needed to develop more globally relevant understanding (Abbott et al. 2021; Bals et al. 2024); such as North America and Asia where digital circular platforms are emerging but the role of intermediaries remains less explicitly theorized (Ranta et al. 2018; Cramer 2020; Wu, Xie, and Hao 2022; Li, Maxwell, and Moehler 2025).

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Author contributions

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Data availability statement

The data that support the findings of this study are available on request from the corresponding author, LD.

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